

## CLAIMS

What is claimed is:

1           1.     A method comprising:  
2     determining a result based upon a network path of a received packet;  
3     identifying, from a plurality of bins, at least one bin corresponding to the result, each of  
4         the plurality of bins including a number of sets of fields; and  
5     searching the at least one corresponding bin to identify a set of fields matching the  
6         packet.

1           2.     The method of claim 1, further comprising:  
2     identifying an action associated with the set of matching fields; and  
3     applying the action to the packet.

1           3.     The method of claim 1, wherein the set of matching fields includes a  
2     transport level field.

1           4.     The method of claim 1, wherein determining the result comprises  
2     identifying a single most specific filter matching the packet.

1           5.     The method of claim 4, wherein the network path of the packet is  
2     expressed as a source address and a destination address.

1           6.       The method of claim 5, wherein identifying the single most specific  
2 matching filter comprises:  
3 performing a look-up in a first data structure to find an entry matching the source address  
4 of the packet; and  
5 performing a look-up in a second data structure to find an entry matching the destination  
6 address of the packet.

1           7.       A method comprising:  
2 receiving a packet, the packet having a header including a source address, a destination  
3 address, and a number of other fields;  
4 identifying, from a number of entries in a data structure, an entry having a source address  
5 prefix matching the source address of the packet, the matching entry including a  
6 first identifier;  
7 identifying, from a number of entries in another data structure, an entry having a  
8 destination address prefix matching the destination address of the packet, the  
9 matching entry including a second identifier;  
10 identifying, from a number of bins, a bin corresponding to the first and second identifiers,  
11 the corresponding bin including a number of sets of transport level fields; and  
12 comparing at least one of the other fields of the packet header with each set of transport  
13 level fields in the corresponding bin to find a matching set of transport level  
14 fields.

1           8.     The method of claim 7, further comprising applying to the received packet  
2     an action associated with the matching set of transport level fields.

1           9.     The method of claim 7, wherein the number of other fields in the packet  
2     header includes at least one of a protocol, a source port, and a destination port.

1           10.    The method of claim 9, wherein the source address of the packet header  
2     comprises a source IP (Internet Protocol) address and the destination address of the  
3     packet header comprises a destination IP address.

1           11.    A method comprising:  
2    receiving a packet, the packet having a header including a source address, a destination  
3           address, and a number of transport level fields;  
4    searching a source address data structure to find a first index and a third index, the first  
5           index associated with a fully specified filter having a source prefix matching the  
6           source address of the packet, the third index associated with a partially specified  
7           filter having a source prefix matching the source address of the packet;  
8    searching a destination address data structure to find a second index and a fourth index,  
9           the second index associated with a fully specified filter having a destination prefix  
10          matching the destination address of the packet, the fourth index associated with a  
11          partially specified filter having a destination prefix matching the destination  
12          address of the packet;  
13   forming a key from the first and second indexes;  
14   searching a primary table for an entry matching the key, the primary table including a  
15          number of entries, each entry corresponding to one of a fully specified filter, a  
16          fully specified filter intersection, and an indicator filter; and  
17   if a matching entry is found in the primary table, accessing a list of bin pointers  
18          associated with the matching entry, each bin pointer of the list identifying a bin  
19          containing a number of sets of transport level fields.

1           12.    The method of claim 11, further comprising:  
2    accessing one of the bins identified by one of the bin pointers in the matching entry of the  
3           primary table;  
4    comparing the transport level fields of the packet with each set of transport level fields in  
5           the accessed bin; and  
6    if the accessed bin has a set of transport level fields matching the transport level fields of  
7           the packet, applying an action associated with the matching set of transport level  
8           fields to the received packet.

1           13.    The method of claim 11, further comprising:  
2    searching a first of two secondary tables for an entry matching the third index, the first  
3           secondary table including a number of entries, each entry corresponding to a  
4           partially specified filter;  
5    searching a second of the two secondary tables for an entry matching the fourth index, the  
6           second secondary table including a number of entries, each entry corresponding to  
7           a partially specified filter; and  
8    if no match is found in the primary table and a matching entry is found in one of the two  
9           secondary tables, accessing a list of bin pointers associated with the matching  
10          entry, each bin pointer of the list identifying a bin containing a number of sets of  
11          transport level fields.

1           14.    The method of claim 13, further comprising:  
2    accessing one of the bins identified by one of the bin pointers in the matching entry of the  
3           one secondary table;  
4    comparing the transport level fields of the packet with each set of transport level fields in  
5           the accessed bin; and  
6    if the accessed bin has a set of transport level fields matching the transport level fields of  
7           the packet, applying an action associated with the matching set of transport level  
8           fields to the received packet.

1           15.    The method of claim 13, further comprising:  
2    if no match is found in either of the secondary tables, accessing a list of bin pointers  
3           associated with a default entry, each bin pointer of the list identifying a bin  
4           containing a number of sets of transport level fields.

1           16.    The method of claim 15, wherein the default entry corresponds to an entire  
2    two-dimensional address space.

1           17.    The method of claim 11, further comprising  
2    searching the source address data structure to find a fifth index associated with a wide  
3           filter having a source prefix matching the source address of the packet;  
4    searching the destination address data structure to find a sixth index associated with a  
5           wide filter having a destination prefix matching the destination address of the  
6           packet;  
7    forming a second key from the fifth and sixth indexes;  
8    searching a wide filter table for an entry matching the second key, the wide filter table  
9           including a number of entries, each entry corresponding to a wide filter; and  
10   if no match is found in the primary table and a matching entry is found in the wide filter  
11       table, accessing a list of bin pointers associated with the matching entry in the  
12       wide filter table, each bin pointer of the list identifying a bin containing a number  
13       of sets of transport level fields.

1           18.    The method of claim 17, further comprising:  
2    accessing one of the bins identified by one of the bin pointers in the matching entry of the  
3           wide filter table;  
4    comparing the transport level fields of the packet with each set of transport level fields in  
5           the accessed bin; and  
6    if the accessed bin has a set of transport level fields matching the transport level fields of  
7           the packet, applying an action associated with the matching set of transport level  
8           fields to the received packet.

1            19.    The method of claim 17, wherein each wide filter contained in the wide  
2 filter table comprises a fully specified filter having a number of indicator filters  
3 exceeding a specified threshold.

1            20.    The method of claim 11, wherein the number of transport level fields in  
2 the received packet comprises at least one of a source port, a destination port, and a  
3 protocol.

1            21.    A method comprising:  
2 grouping a plurality of rules of a packet classification database into a number of rule sets,  
3 each rule set including rules having a source and destination address pair, each  
4 rule set associated with a filter corresponding to the source and destination  
5 address pair;  
6 associating a small bin with each of the filters, each small bin including a group of a  
7 number of sets of transport level fields, each set of transport level fields in the  
8 group associated with one of the rules in the associated rule set.

1            22.    The method of claim 21, wherein at least two of the filters are associated  
2 with a same small bin.



1           23.     The method of claim 21, further comprising identifying a number of filter  
2 intersections, each filter intersection corresponding to an intersection of at least two of  
3 the filters.

1           24.     The method of claim 23, further comprising associating a large bin with  
2 each of the filter intersections, the large bin of each filter intersection comprising a union  
3 of the small bins associated with each of the at least two filters of the intersection.

1           25.     The method of claim 24, further comprising identifying a number of  
2 indicator filters, each indicator filter formed from a source address of one of the filters  
3 and the destination address of another of the filters.

1           26.     The method of claim 25, wherein the filters associated with the  
2 classification database includes fully specified filters, partially specified filters extending  
3 an entire source address space, and partially specified filter extending an entire  
4 destination address space.

1           27.    The method of claim 26, further comprising:  
2    creating a primary table including a number of entries, each entry of the primary table  
3           associated with one of the fully specified filters, one of the filter intersections, or  
4           one of the indicator filters, each entry of the primary table including a key and at  
5           least one pointer to the small bin associated with the corresponding filter of that  
6           entry;  
7    creating a first secondary table including a number of entries, each entry of the first  
8           secondary table associated with one of the partially specified filters having a  
9           source address extending the entire source address space, each entry of the first  
10          secondary table including a key and a pointer to the small bin associated with the  
11          corresponding filter of that entry; and  
12    creating a second secondary table including a number of entries, each entry of the second  
13          secondary table associated with one of the partially specified filters having a  
14          destination address extending the entire destination address space, each entry of  
15          the second secondary table including a key and a pointer to the small bin  
16          associated with the corresponding filter of that entry.

1           28.    The method of claim 27, wherein the at least one pointer in one entry of  
2    the primary table identifies a large bin associated with a corresponding filter intersection  
3    of that entry.

1           29.    The method of claim 27, wherein the primary table includes a subset of  
2   the number of indicator filters.

1           30.    The method of claim 27, wherein the filters associated with the  
2   classification database further includes wide filters.

1           31.    The method of claim 30, further comprising creating a wide filter table  
2   including a number of entries, each entry of the wide filter table associated with one of  
3   the wide filters, each entry of the wide filter table including a key and a pointer to the  
4   small bin associated with the corresponding filter of that entry.

1           32.    The method of claim 21, further comprising:  
2   creating a source address data structure, the source address data structure including a  
3       number of entries, each of the entries including a source prefix corresponding to  
4       one of the filters; and  
5   creating a destination address data structure, the destination address data structure  
6       including a number of entries, each of the entries including a destination prefix  
7       corresponding to one of the filters.

1           33.    A data structure comprising:  
2    a plurality of filters, each filter including a source address prefix and a destination  
3           address prefix; and  
4    a plurality of bins, each bin comprising a number of triplets, each triplet including at least  
5           one transport level field, an action, and a priority;  
6    wherein each of the plurality of filters is associated with at least one of the bins.

1           34.    The data structure of claim 33, wherein one of the bins is associated with  
2    at least two of the filters.

1           35.    The data structure of claim 33, wherein the source address prefix  
2    comprises a source IP (Internet Protocol) address prefix and the destination address prefix  
3    comprises a destination IP address prefix.

1           36.    The data structure of claim 33, wherein the at least one transport level  
2    field comprises one of a protocol, a source port, and a destination port.

1           37.    The data structure of claim 33, wherein each of at least some of the bins  
2    comprises a small bin.

1           38.     The data structure of claim 37, wherein at least one of the bins comprises a  
2     large bin, the large bin comprising a union of the small bins associated with a filter  
3     intersection.

1           39.     A data structure comprising:  
2     a source address data structure, the source address data structure including a number of  
3         entries, each of the entries having a source prefix, a filter type, and an index;  
4     a destination address data structure, the destination address data structure including a  
5         number of entries, each of the entries having a destination prefix, a filter type, and  
6         an index;  
7     a primary table, the primary table including a number of entries, each of the entries  
8         having a key and at least one bin pointer, wherein each of the entries is associated  
9         with one of a fully specified filter, a fully specified filter intersection, and an  
10        indicator filter; and  
11    two secondary tables, each of the secondary tables including a number of entries, each of  
12       the entries having a key and at least one bin pointer, wherein each entry of each of  
13       the two secondary tables is associated with a partially specified filter.

1           40.     The data structure of claim 39, wherein one of the secondary tables is  
2     associated with partially specified filters having a source address expanding an entire  
3     source address space, and the other of the two secondary tables is associated with  
4     partially specified filters having a destination address expanding an entire destination  
5     address space.

1           41.     The data structure of claim 39, wherein the filter type in each of the source  
2     address and destination address look-up tables indicates one of a fully specified filter and  
3     a partially specified filter.

1           42.     The data structure of claim 39, further comprising a wide filter table, the  
2     wide filter table including a number of entries, each of the entries having a key and at  
3     least one bin pointer, wherein each entry of the wide filter table is associated with a wide  
4     filter.

1           43.     The data structure of claim 42, wherein the filter type in each of the source  
2     address and destination address look-up tables indicates one of a fully specified filter, a  
3     partially specified filter, and a wide filter.

1           44.     The data structure of claim 39, wherein each of the bin pointers in the  
2     entries of the primary and secondary tables identifies one of a plurality of bins of a  
3     second data structure, each bin including a number of triplets, each triplet having at least  
4     one transport level field, an action, and a priority

1           45.     The data structure of claim 44, wherein each source address prefix in the  
2     source address data structure comprises a source IP (Internet Protocol) address prefix and  
3     each destination address prefix in the destination address data structure comprises a  
4     destination IP address prefix.

1           46.     The data structure of claim 45, wherein the at least one transport level  
2     field comprises one of a protocol, a source port, and a destination port.

1           47.     The data structure of claim 39, wherein the primary table includes entries  
2     for a subset of all possible indicator filters.

1        48.    An apparatus comprising:  
2        a processing device;  
3        a memory coupled with the processing device, the memory having a first data structure  
4        stored therein, the first data structure including  
5                a source address look-up data structure, the source address look-up data  
6                structure including a number of entries, each of the entries having a  
7                source prefix, a filter type, and an index,  
8                a destination address look-up data structure, the destination address look-  
9                up data structure including a number of entries, each of the entries  
10                having a destination prefix, a filter type, and an index,  
11                a primary table, the primary table including a number of entries, each of  
12                the entries having a key and at least one bin pointer, wherein each  
13                of the entries is associated with one of a fully specified filter, a  
14                fully specified filter intersection, and an indicator filter, and  
15                two secondary tables, each of the secondary tables including a number of  
16                entries, each of the entries having a key and at least one bin  
17                pointer, wherein each entry of each of the two secondary tables is  
18                associated with a partially specified filter.



1           49.    The apparatus of claim 48, further comprising:  
2    a second memory coupled with the processing device, the second memory having a  
3           second data structure stored therein, the second data structure including a plurality  
4           of small bins, each small bin including a number of triplets, each triplet having at  
5           least one transport level field, an action, and a priority;  
6    wherein each of the bin pointers in the entries of the primary and secondary tables  
7           identifies one of the small bins of the second data structure.

1           50.    The apparatus of claim 49, wherein the second memory comprises a  
2    content addressable memory.

1           51.    The apparatus of claim 49, wherein the at least one transport level field  
2    comprises one of a protocol, a source port, and a destination port.

1           52.    The apparatus of claim 51, wherein the second data structure stored in the  
2    second memory includes at least one large bin, the large bin comprising a union of small  
3    bins associated with a filter intersection.

1           53.    The apparatus of claim 48, wherein the memory comprises at least one of  
2    a SRAM, DRAM, SDRAM, and a DDRDRAM.

1           54.     The apparatus of claim 48, wherein the memory comprises part of the  
2 processing device.

1           55.     The apparatus of claim 48, wherein one of the secondary tables is  
2 associated with partially specified filters having a source address expanding an entire  
3 source address space, and the other of the two secondary tables is associated with  
4 partially specified filters having a destination address expanding an entire destination  
5 address space.

1           56.     The apparatus of claim 48, wherein the filter type in each of the source  
2 address and destination address look-up tables comprises one of a fully specified filter  
3 and a partially specified filter.

1           57.     The apparatus of claim 48, wherein the first data structure further  
2 comprises a wide filter table, the wide filter table including a number of entries, each of  
3 the entries having a key and at least one bin pointer, wherein each entry of the wide filter  
4 table is associated with one of a wide filter and an indicator filter.

1           58.     The apparatus of claim 57, wherein the filter type in each of the source  
2 address and destination address look-up data structures comprises one of a fully specified  
3 filter, a partially specified filter, and a wide filter.

1           59.     The apparatus of claim 48, wherein each source address prefix in the  
2     source address look-up data structure comprises a source IP (Internet Protocol) address  
3     prefix and each destination address prefix in the destination address look-up data  
4     structure comprises a destination IP address prefix.

1           60.     The apparatus of claim 48, wherein the primary table includes entries for a  
2     subset of all possible indicator filters.

1           61.     An apparatus comprising:  
2     a content addressable memory (CAM), the CAM having stored therein a plurality of bins,  
3     each of the bins including a number of sets of fields; and  
4     a processing device coupled with CAM, the processing device capable of determining a  
5     result based upon the network path of the packet and identify, from the plurality  
6     of bins, at least one bin corresponding to the result, the CAM to search the at least  
7     one corresponding bin to identify a set of fields matching the packet.

1           62.     The apparatus of claim 61, wherein the CAM returns an action associated  
2     with the set of matching fields, the processing device capable of executing the action.

1           63.     The apparatus of claim 61, wherein the matching set of fields includes a  
2     transport level field.

1           64.     The apparatus of claim 61, wherein the processing device, when  
2     determining the result, identifies a single most specific filter matching the packet.

1           65.     An article of manufacture comprising:  
2     a machine accessible medium providing content that, when accessed by a machine,  
3     causes the machine to  
4             determine a result based upon a network path of a received packet;  
5             identify, from a plurality of bins, at least one bin corresponding to the result, each  
6             of the plurality of bins including a number of sets of fields; and  
7             search the at least one corresponding bin to identify a set of fields matching the  
8             packet.

1           66.     The article of manufacture of claim 65, wherein the content, when  
2     accessed, further causes the machine to:  
3     identify an action associated with the set of matching fields; and  
4     apply the action to the packet.

1           67.     The article of manufacture of claim 65, wherein the set of matching fields  
2     includes a transport level field.

1           68.    The article of manufacture of claim 65, wherein the content, when  
2   accessed, further causes the machine, when determining the result, to identify a single  
3   most specific filter matching the packet.

1           69.    The article of manufacture of claim 68, wherein the network path of the  
2   packet is expressed as a source address and a destination address.

1           70.    The article of manufacture of claim 69, wherein the content, when  
2   accessed, further causes the machine, when identifying the single most specific matching  
3   filter, to:  
4   perform a look-up in a first data structure to find an entry matching the source address of  
5       the packet; and  
6   perform a look-up in a second data structure to find an entry matching the destination  
7       address of the packet.